U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

NRC Role at Saltstone

Monitoring Activities and the PA Review

George Alexander, Systems Performance Analyst

Performance Assessment Branch

Nuclear Regulatory Commission

January 25, 2011

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Objectives

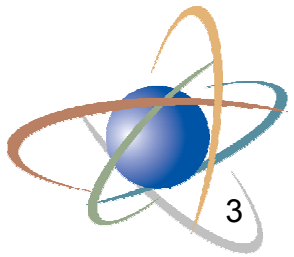
- Role of NRC at SRS
- Saltstone Monitoring
- Saltstone Performance Assessment Review

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Role of NRC at SRS

Key Points

- Section 3116, National Defense Authorization Act for Fiscal Year 2005 (NDAA)
  - Consultation
  - Monitoring
- NUREG-1854 - Staff Guidance on DOE Waste Determinations
- NUREG-1911 - Annual NDAA Monitoring Report

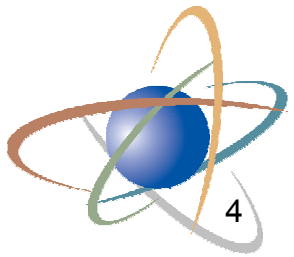


U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Monitoring

NRC Process

- Evaluation of reasonable assurance that DOE can meet the performance objectives of 10 CFR Part 61
  - § 61.41: Protection of the general population from releases of radioactivity [25 mrem]
  - § 61.42: Protection of individuals from inadvertent intrusion [500 mrem]
  - § 61.43: Protection of individuals during operations
  - § 61.44: Stability of the disposal site after closure
- Chapter 10 of NUREG-1854 (staff guidance) provides a detailed description of NRC's monitoring program



History of Saltstone Project

NRC/DOE NDAA Activities

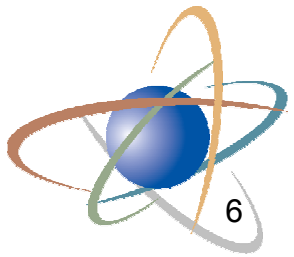
- 2005 NRC Review of Saltstone PA identified numerous key assumptions and data gaps
- NRC review concluded that the performance objectives could be met if key assumptions are valid
- Research has been developed further by DOE since 2005
- NRC has reviewed data as the reports have been made available
- NRC staff is currently reviewing the revised PA

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Saltstone Monitoring Plan

Key Factors Important to Assessing Compliance

- Factor 1: Oxidation of Saltstone
- Factor 2: Hydraulic Isolation of Saltstone
- Factor 3: Model Support
- Factor 4: Erosion Control Design
- Factor 5: Infiltration Barrier Performance
- Factor 6: Feed Tank Sampling
- Factor 7: Tank 48 Wasteform
- Factor 8: Removal Efficiencies



U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

DOE Research

Results

Research Topic	Description of Results
Hydraulic properties of saltstone	• Research has indicated that the assumed hydraulic conductivity in the 2005 PA was optimistic
Physical integrity of saltstone	• Cracking of saltstone in Vault 4 has been observed • Core samples crumbled when removed from the monolith
Fracturing of vault walls	• 2005 PA assumed the vault walls would serve as a diffusive and flow barrier, but radioactive liquid has seeped through Vault 4 walls
Reduction and retention of Tc in saltstone	• SRS lab experiments have not been provided to the NRC that demonstrate Tc is reduced and retained
Inventory of Th-230/Ra-226	• Ra-226 drives the dose in the current PA , but it was not identified as a key radionuclide in 2005 PA • 2005 PA assumed 0.0353 Ci Th-230 and 13 Ci Ra-226 for SDF • 2009 PA assumed 20 Ci Th-230 and 4.1 Ci Ra-226 for SDF

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Saltstone PA Review

RAI-2009-02 Description

Comment Topics	Performance Objectives	Technical Concerns
Performance Assessment Methods	61.41 61.42 61.44	Base Case Assumptions; Model Support; Synergistic Case; Hybrid Approach; Calcareous Zones; Benchmarking;
Inventory	61.41 61.42 61.43	Th-230 and Ra-226; Uncertainty; Distribution; Feed Tank and Sampling
Infiltration and Erosion Control	61.41 61.42 61.44	Lateral Drainage Layer
Saltstone Performance	61.41 61.42	Hydraulic properties; Longevity of Reducing Conditions and Tc-99 Release; Sorption; Diffusion
Vault Performance	61.41 61.42 61.44	Degradation Mechanisms; Reducing Capacity; Observations; Bypassing Flow
Far-field transport	61.41	Sorption; Calcareous Zones
Inadvertent Intrusion	61.42	Pathways; Basis for Calculation
Biosphere	61.41	Transfer Factors; Pathways; Ingestion Rate

10 CFR Part 61, Subpart C – Performance Objectives

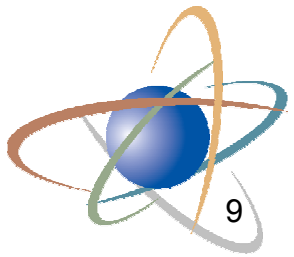
61.41 Protection of the general population from releases of radioactivity
61.42 Protection of individuals from inadvertent intrusion
61.43 Protection of individuals during operations
61.44 Stability of the disposal site after closure

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Model Assumptions

Base Case (Case A)

- Inconsistent with known conditions
- Limited model support
- Inadequate accounting of uncertainty (e.g., one-off sensitivity analyses)
- Technical concerns
  - Technetium reduction and retention
  - Hydraulic conductivity of saltstone and vaults
  - Moisture characteristic curves
  - Lateral drainage layer performance
  - Degradation of vaults and saltstone



U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NRC Concerns

Technetium Release from Saltstone

- The release of technetium is based on its oxidation state. Under reducing conditions, it is expected that technetium will sorb strongly. If technetium is not reduced and retained, the dose is likely to be high.
- Saltstone contains slag to create reducing conditions and retain technetium, but based on the data received to date the reduction and retention of Tc-99 in saltstone is not clear.

Assumed K_d values - (mL/g)		K_d Values Measured by SRS - (mL/g)		
2005 PA (1)	2009 PA (1)	SRNS-STI-2008-00045 sample exposed to air (2)	SRNS-STI-2008-00045 sample under N_2 (3)	SRNL-STI-2009-00636 (4)
1000	1000 – 5000	0.16 - 0.93	6.5 - 91.3	9.1 - 56

(1) based on literature information published by Bradbury and Sarrott (1995). The basis for these values is a report by Bayliss et al. that contained a strong reducing agent, sodium dithionite. In addition, this paper appears to be a conference presentation and may not have been peer reviewed.
(2) from Table 2
(3) from Table 3. Note that this data is reported with the following comment : "quality of the spectra generated for the analyses was compromised by the U-233 peak shift into the Tc-99 region of the spectra"
(4) note that this K_d value is reported incorrectly in the abstract to this document

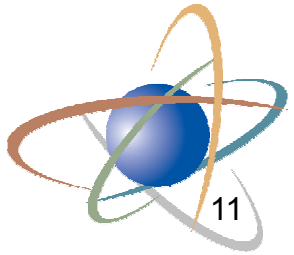
U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NRC Concerns

Hydraulic Conductivity

Years	Assumed Hydraulic Conductivity, K at SRS (cm/s)		Hydraulic Conductivity Measurements – (cm/s)			
	2005 PA	2009 PA	WSRC-STI-2007-00649[1] (no CO_2)	WSRC-STI-2008-00421[1]	WSRC-STI-2009-00419[1,2] (at 60°C)	Core Sample
Initial	1.0 E-11	2.0 E-9	6.0 E-9 to 3.0 E-8	1.2 E-9 to 8.8 E-8	8.6 E-7	TBD
10000	1.0 E-9	2.0 E-9	--	--	--	--

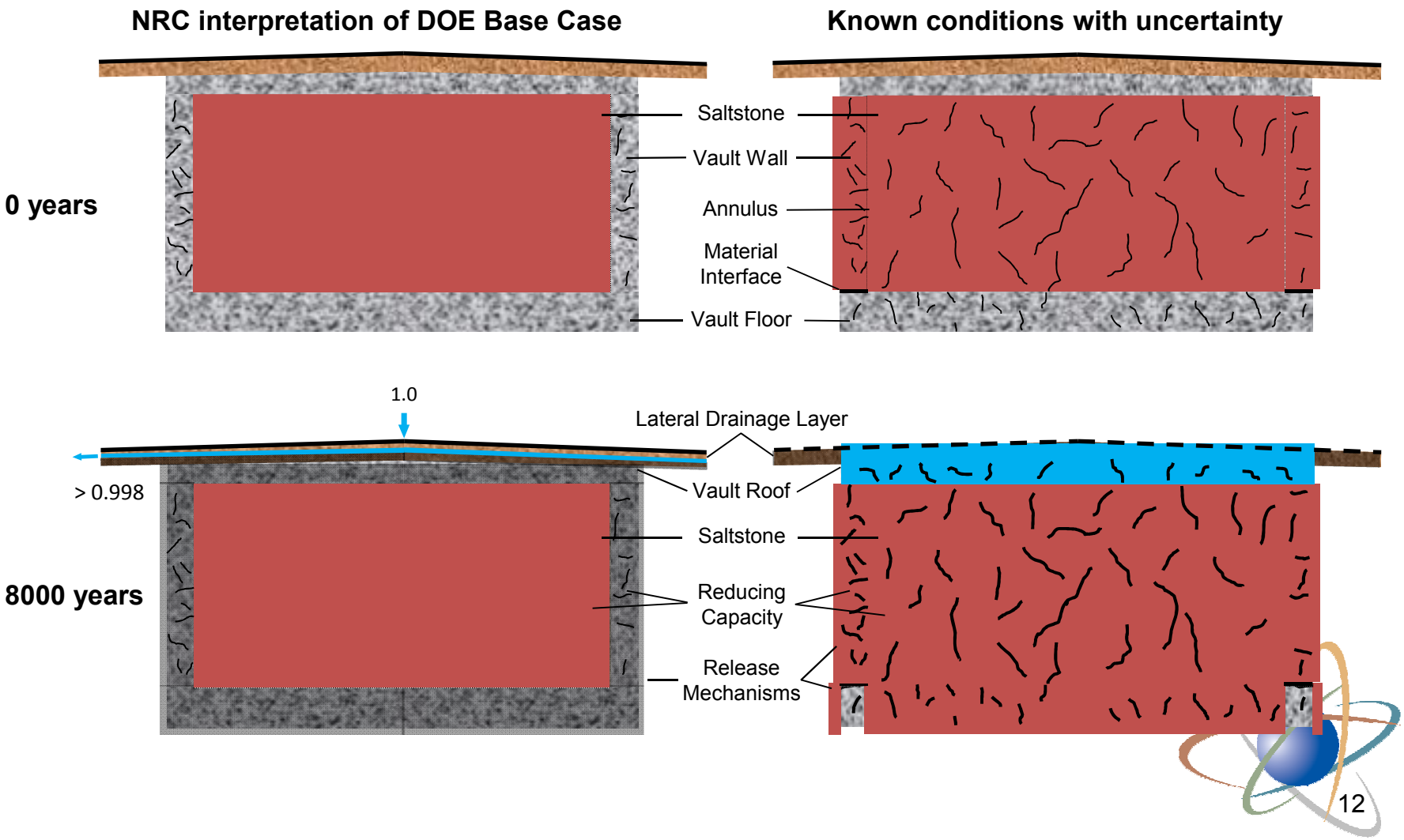
[1]Samples did not account for (i) scale, (ii) field-emplacement, (iii) CO_2, (iv) permeability evolution
[2]Accounted for organics, admixtures, and a cure temperature of 60°C



U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NRC Concerns

Conceptual Model - Vault 4



U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NRC Concerns

Revisions to Base Case

Revisions:

- Moisture characteristic curves (MCC) for cementitious materials
- Hydraulic conductivity (K) for lateral drainage layer (LDL) , clean grout, and saltstone

Outstanding:

- Fracturing of saltstone and vaults
- Flow through the walls
- Hydraulic conductivity values that account for degradation, scale, field-emplacement, CO_2 contamination, and permeability evolution

Flow through saltstone grout at 500 years

1 – Base Case

2 – Revised:
- MCC for Saltstone and Clean Grout

3 – Revised:
- LDL

4 – Revised:
- K for Saltstone and Clean Grout

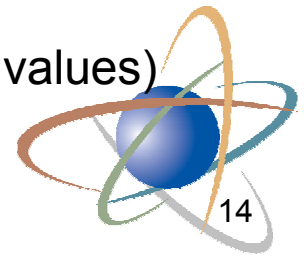
5 – Revised:
- LDL
- K and MCC for Saltstone and Clean Grout

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NRC Concerns

Alternative Analyses

- Synergistic Case
  - Assumptions
    - Earlier degradation of the closure cap
    - Degradation of the vaults at year 500
    - Fractured saltstone at closure
  - Conservatism of the synergistic case is unclear (e.g., flow through saltstone, reducing capacity, biosphere parameters)
- Hybrid Approach
  - Concerns with implementation (e.g., coupling of PORFLOW and GoldSim models, probability of cases, benchmarking of certain radionuclides)
  - Limited bases for parameter distributions (e.g., inventory, K_d values)



U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NRC Concerns

Summary

- NDAA History of Saltstone Project
  - Monitoring plan based on TER for 2005 WD
  - DOE performed research in the area of key factors
  - NRC reviews research as it is available
  - Previous assumptions demonstrate optimistic bias
  - NRC has been reviewing 2009 PA since Nov 2009

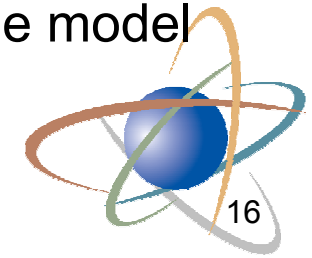
U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NRC Concerns

Summary (cont.)

NRC requested additional information to address questions and concerns:

- Review was risk-informed and focused on key assumptions
- Current RAIs address the following issues:
  - Degree of compatibility between the conceptual model and mathematical model
    - As built conditions
    - Degradation processes over time
    - Flow through system
  - Basis for key data and parameters assumed in the model
  - Additional model support for key assumptions in the model



U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Questions?